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Original Article

Evaluation of demographic and clinical profile of snakebite casualties presented at a tertiary care hospital in Kerala

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ABSTRACT

Problem considered: India has the highest number of envenomation and the highest number of deaths due to snakebite in the world. However, there is wide variation in the regional prevalence of snake species involved in causation of snakebites. The objectives of the study were to determine the prevalence of causative species involved in snakebites presented to the institution and identification of risk factors that triggered the infliction.

Methods: The cross-sectional study was conducted among snakebite casualties admitted to a tertiary care hospital in Malappuram district of Kerala. Data were collected from the medication charts of confirmed bite victims admitted to critical care unit of the hospital prospectively. Statistical analysis was performed using χ^2 , Student's t-test and ANOVA.

Results: The sample comprised of 60 (65.9%) males and 31 (34.1%) females, fashioning a gender ratio of 1.93. The causative snake species was unidentified in 48 (52.7%) instances. Russel's viper, hump nose viper (HNV), spectacled cobra and common krait were involved in 21 (23.1%), 14 (15.4%), 5 (5.5%) and 3 (3.3%) inflictions respectively. 77 (84.6%) victims were residents of rural area in opposition to 14 (15.4%) from urban area. 80 (87.9%) subjects presented with an alleged bite at lower extremities as opposed to 11 (12.1%) with infliction on upper extremities.

Conclusions: Russel's viper constituted the most prevalent species among identified cases in the study setting. Male gender, working class population, outdoor occupation without adequate protective footwear, monsoon season and rural residency were identified as risk factors for contracting snakebites.

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1. Introduction

India is home to 60 species of venomous snakes, with few of them being abundant in rural locations and causing serious envenomation incidents.¹ India is estimated to have the highest snakebite mortality in the world with World Health Organization (WHO) estimates indicating a high frequency of 83,000 bites per annum with 11,000 deaths.² In the Indian sub-continent, the envenomed snakebites have been linked to “the big four” comprising of Indian cobra, common krait, Russell's viper and saw-scaled viper. Anti-snake venom is a biological product that typically consists of venom neutralizing antibodies derived from a host animal, such as a horse or sheep and has been widely utilized to subdue manifestations associated with the envenomation. Depending on the species covered by the antivenom, it is classified as either monovalent, which can counteract against the bite of a single species; or polyvalent, having coverage against multiple snake species. There are international and national quality standards set by the WHO and Indian Pharmacopoeia respectively; which the ASV manufacturers has to abide by. The major dilemma faced by clinicians is that despite harbouring multiple venomous species in its biosphere, the clinical manifestations of many species in India resemble each other to an extent that, accurate diagnosis of the bite is usually ascertained by identifying the snake brought in by victim's relatives. Performing immunological tests for identification cannot be a feasible option in a lower-middle income country like India and therefore, the tendency has been to manufacture polyvalent antivenom, having coverage against the big four. However, polyvalent antivenoms are known to be less effective than monovalent antivenoms, and are more likely to induce allergic reactions, including anaphylactic shock.³ Recently, various studies have revealed that the hump-nosed viper, previously considered harmless and misidentified as the saw-scaled viper, is capable of delivering a fatal bite.⁴ In regions of Kerala, India, it may be responsible for nearly 10% of venomous bites and the polyvalent ASV provides no coverage against their venom.^{5,6} Adding to these problems, there has been acute shortage of anti-snake venom in the country which the manufacturers claim is due to the lack of supply of raw materials. But there has been widespread allegation that the drug price control order 2013, which had reduced the price of ASV by half has been instrumental in shaping the manufacturers' response to intentionally cease production. The following study was aimed at studying envenomed and non-envenomed snakebite cases admitted to a tertiary care hospital in Northern Kerala, with respect to patient demographics, temporal variabilities and clinical manifestations. The major objective of the study was to determine the prevalence of causative species involved in snakebites presented to the institution. Secondary objective involved identification of risk factors and use them to delineate emphasis areas during prospective public awareness programmes, aimed at reducing snakebite casualties in the specific locality.

2. Material and methods

A cross-sectional study was conducted to scrutinize the pattern of snakebite and estimate predisposing factors among envenomed and non-envenomed snakebite casualties admitted to a tertiary care hospital in Malappuram district of Kerala. The hospital provides health services to the natives of this hilly terrain and also acts as a referral centres for snakebite cases in the region. The study was carried out from February 2012 to August 2014 in the Critical Care unit of the hospital. All cases of confirmed snakebite casualties were included in the study through continuous sampling method. The cases which were suspected as snakebites and on further evaluation found to be non-snakebites were excluded. The study got ethical clearance from the institutional ethical committee of the hospital, prior to enrolment of first subject. Informed consent was obtained from the patient's relatives as well as the treating physician prior to collection of data from each individual. The time at which the victims were brought to the hospital and the time taken to bring the victim to the institution under study were noted. Patients not presenting with fang marks were not excluded because of the fact that in many instances, Krait bites were not been found to be associated with fang marks. Confirmation of the snake species involved was done through visual examination of the dead or live snake that was brought to hospital or based on descriptions and testimony of accompanier. Clinical signs and laboratory values were used to assess the severity and classify them as local or systemic envenomation. The therapies administered for management of the cases were analyzed and the number of vials of ASV administered was noted if any. The parameters which were used as indication for ASV therapy were also scrutinized. The lab diagnostic tests used to further evaluate the effectiveness of therapy were noted. The requisite sample size was estimated based on retrospective evaluation of snakebite medication records. The pilot study evidenced that the causative species could be identified in 53.33% instances. The following equation was used to determine the minimum required sample size as 87.

$$n = \frac{4pq}{d^2}$$

where n = minimum required sample size, p = 53.33%, q = $1 - p$ and d is the precision (taken as 20% of p).

SPSS version 18.0 was used for data analysis and the level of significance was set at 5% with p value <0.05 being considered as statistically significant. The data are presented as means $\pm$ standard deviation for continuous variables and frequency (percentage) for discrete variables. Differences in categorical and continuous variables were tested with χ^2 and Student's t -tests, respectively. Significance of difference between means of multiple groups was analyzed using ANOVA. Association of the potential risk factors with the clinical manifestations was assessed using Spearman's correlation.

3. Results

A total of 91 subjects who met the pre-determined criteria during the investigation period were enrolled in the study

group. The sample comprised of 65.9% males and 34.1% females, fashioning a male to female ratio of 1.93 (Table 1). The difference in proportion of male and female victims was found to be significant with $p = 0.002$ ($\chi^2 = 9.24$). The mean age of the study sample was estimated as 36.86 ± 17.99 years and a relatively superior proportion (20.9%) of subjects were aged between 40 and 50 years. The mean age of males was appraised as 35.47 ± 19.8 years, whereas the mean age of females was found to be 39.55 ± 13.75 years. The difference between mean age of males and females was found to be non-significant with $p = 0.308$ ($t = -1.026$). Fig. 1 depicts that 41.76% of the snakebite admissions occurred during the southwest monsoon in Kerala (May to July) and 21.98% during northeast monsoon in Kerala (October and November). The difference between the number of casualties during the monsoon and non-monsoon seasons was found to be significant with $p = 0.009$ ($\chi^2 = 6.87$). Relatively greater proportion of snakebite casualties occurred during 12 PM to 6 PM, accounting to 35.2% of the incidents. The difference in distribution of casualties with regard to time was found to be significant with $p = 0.024$ ($\chi^2 = 9.44$). 84.6% victims were residents of rural area in opposition to 15.4% from urban area, with the difference proving to be statistically significant yielding $p < 0.001$ ($\chi^2 = 43.61$). The average time taken for presentation of cases to emergency department of the institution was found to be 2.48 ± 5.55 h, with 73.6% casualties brought in within 2 h of infliction. 87.9% subjects had presented with an alleged bite at lower extremities as opposed to 12.1% with infliction on upper extremities. The location of bite was found to be toes, feet, leg (above ankle) and finger in 24.18%, 47.25%, 16.48% and 12.09% subjects respectively. A significant correlation was evident between the location of bite and gender of the subject with $p = 0.027$. The odds of subject being male, with an infliction on lower extremity was found to be 4.08. The difference in distribution of males and females with regard to location of bite was found to be significant with $p = 0.027$ ($\chi^2 = 4.84$). The most common presenting complaints involved warmth coupled with swelling at location of bite, vomiting and tiredness.

The causative snake species was unidentified in 52.7% instances. In 52.7% instances, the snake species was identified and on stratification, *Viperidae* family was found to account for most cases. *Daboia russeii* (Russell's viper) was the individual species responsible for most identified bites, with a share of 23.1% and was closely followed by *Hypnale hypnale* (hump nose viper, HNV) blameworthy for 15.4% bites. The bites by the two elapids: *Naja naja* (spectacled cobra) and *Bungarus caeruleus* (common krait) constituted 5.5% and 3.3%, respectively. The difference in distribution of casualties with regard to causative species was found to be significant with $p < 0.001$ ($\chi^2 = 72.46$). Among the victims, 58.24% were found to non-envenomed, 25.27% were systemically envenomed and 16.48% were locally envenomed on further assessment. The most frequent complication in the study sample was acute renal failure, which manifested in 7.69% patients, with 2 of them requiring dialysis. 31.86% victims were administered ASV, with each patient receiving an average of 15.62 ± 8.23 vials. Among these, 6.9% patients developed hypersensitivity reaction against ASV. Each subject was admitted to the hospital for an average of 2.66 ± 4.57 days.

Table 1 – Demographic and clinical features of snakebite casualties presented to the hospital during study period.

Demographic/Clinical feature	Frequency (Percentage)
No of subjects enrolled	91
Males	60 (65.9%)
Females	31 (34.1%)
Mean Age	36.86 ± 17.99 years
Mean age of Male	35.47 ± 19.8 years
Mean age of Female	39.55 ± 13.75 years
Age group distribution of snakebite casualties	
10 years and below	7 (7.7%)
10–20 years	13 (14.3%)
20–30 years	16 (17.6%)
30–40 years	16 (17.6%)
40–50 years	19 (20.9%)
50–60 years	10 (11%)
60 years and above	10 (11%)
Distribution of casualties with regard to time of bite	
12 AM to 6 AM (Early morning)	12 (13.2%)
6 AM to 12 PM (Morning)	26 (28.6%)
12 PM to 6 PM (Afternoon)	32 (35.2%)
6 PM to 12 AM (Evening)	21 (23.1%)
Distribution of latency from snakebite to presentation at the hospital	
<2 h	67 (73.6%)
2–6 h	21 (23.1%)
6–12 h	1 (1.1%)
12–24 h	1 (1.1%)
>24 h	1 (1.1%)
Frequency of presenting symptoms at the time of admission	
Bleeding from gum	1 (1.09%)
Bleeding from previous wounds	1 (1.09%)
Bleeding from wound	1 (1.09%)
Blurring vision	1 (1.09%)
Ecchymosis	2 (2.19%)
Oedema	2 (2.19%)
Gangrene	2 (2.19%)
Heaviness of head	3 (3.33%)
Icterus	3 (3.33%)
Numbness	3 (3.33%)
Ptosis	3 (3.33%)
Tenderness	4 (4.39%)
Tiredness	18 (19.78%)
Vomiting	24 (26.37%)
Warmth & Swelling	28 (30.77.1%)
Distribution of patients with respect to length of hospital stay	
<3 days	76 (83.5%)
3–6 days	9 (9.9%)
6–9 days	1 (1.1%)
9–12 days	3 (3.3%)
>15 days	2 (2.2%)
Frequency of complications among the snakebite victims	
Acute renal failure	7 (7.69%)
Cellulitis	6 (6.59%)
Compartment syndrome	4 (4.39%)
Death	2 (2.19%)
Disseminated intravascular coagulation	2 (2.19%)
Gangrene	2 (2.19%)
Hepato-renal failure	2 (2.19%)
Necrotizing fascitis foot	1 (1.09%)
Frequency distribution of quantity of anti-snake venom used per subject	
<5 vials	65 (71.4%)
5–10 vials	7 (7.7%)
10–15 vials	6 (6.6%)
15–20 vials	5 (5.5%)
>20 vials	8 (8.8%)

Fig. 1 – Simple bar graph representing frequency distribution of casualties with respect to month.

Table 2 – Representation of mean duration of hospitalization with regard to snake species.

Snake species	Mean (days)	F value	p value
Species unidentified	1.33 ± 1.04	6.21	<0.0001
Russel's viper	4.62 ± 4.48		
Cobra	9.60 ± 15.52		
Hump nose viper	1.71 ± 1.49		
Common krait	3.00 ± 1.73		

There was found to be significant difference in the length of hospitalization (Table 2), with regard to the snake species involved in the bite and the difference was found to be significantly different yielding $p < 0.0001$ ($F = 6.21$). The Spearman correlation between snake species and type of envenomation demonstrated correlation with a correlation coefficient of 0.38 (Table 3). A significant correlation was also demonstrated between the snake species and requirement for number of ASV vials with Spearman correlation coefficient yielding value of 0.31. The difference in the mean number of vial used with regard to snake species involved in causality (Table 4) was estimated to be significantly different with $p < 0.001$ ($F = 12.96$). The odds of complication with a Russel's viper bite with respect to odds of complication in any other species was estimated at 8, whereas the odds ratio of complication for HNV and spectacled cobra was found to be 1.31 and 2.1, respectively. The mortality rate associated with snakebites was appraised to be very low accounting to 2 in 100 subjects.

4. Discussion

Among half a million snakebites and between 30,000 and 40,000 snakebite deaths occur each year worldwide of which 25,000–30,000 deaths are contribution from Asia.⁷ India is contributing significant number of cases per annum and is leading the list of countries with most number of snakebite deaths per year. Despite this, much is unknown about the statistical data from this country. In 2009, snakebite was finally included in WHO's list of neglected tropical diseases. Kerala is a southern state of India and is blessed with a rich heritage of fauna and flora. With Western Ghats coming under the biodiversity hotspot region, the Malabar region of Kerala with its undulating hilly terrain is a swarming area of rare and significant species. The major snakebite cases in India is due to the “Big Four” which includes *D. russelii*, *N. naja*, *B. caeruleus* and *Echis carinatus*.⁸ But within India, the predominance of snake species varies geographically, with *E. carinatus* being almost absent in the South India region.⁹

The study shows that males were affected more commonly than females indicating the risk associated with outdoor occupational hazard. Males who are involved in either rubber tapping, construction workers or farmers have been the most frequently affected. The apparent predominance of males in the current study is in line with the result of Jarwani et al., wherein males comprised 75.2% of the casualties.¹⁰ A relatively superior proportion of victims were residents of rural area and the observed value of 84.6% complies with the

Table 3 – Representation of type of envenomation with regard to snake species.

Snake species	Non-envenomed	Locally envenomed	Systemically envenomed	χ^2 value	p value
Species unidentified	40 (44%)	2 (2.2%)	6 (6.6%)	45.68	<0.0001
Russel's viper	3 (3.3%)	13 (14.3%)	5 (5.5%)		
Cobra	1 (1.1%)	4 (4.4%)	0 (0%)		
Hump nose viper	8 (8.8%)	2 (2.2%)	4 (4.4%)		
Common krait	1 (1.1%)	2 (2.2%)	0 (0%)		

Table 4 – Representation of mean number of vials used with regard to snake species.

Snake species	Mean (days)	F value	p value
Species unidentified	1.54 ± 4.31	12.96	<0.0001
Russel's viper	23.48 ± 11.07		
Cobra	14.0 ± 10.22		
Hump nose viper	0.86 ± 3.21		
Common krait	11.67 ± 12.58		

observation of 82.4% made by Sharma et al.¹¹ The mean age of the study sample, appraised as 36.86 ± 17.99 years was lesser than the mean age of 41.9 years, identified in a similar cross-sectional study conducted in Manipal.¹² However, similar to the observation of current study, the age of females was greater than males, even though the difference was insignificant. In both instances, a relative majority of cases were comprised within the 30 to 50-year age group. In the current study, majority of bites were inflicted on lower extremities, an observation consistent with several other studies conducted in different regions of India.^{11,13,14}

This may be attributed to inadequate use of protective footwear among farmers, construction and rubber tapping workers. Majority of the upper limb bites were associated with female gender which reflects the bites occurring while taking wood and other items from the outdoor storage areas. Seasonal peaks of snakebite incidence are usually associated with increases in agricultural activity or seasonal rains, perhaps coinciding with agricultural activity, floods, increased snake activity and profusion of prey organisms like frogs. The pattern is consistent across India despite the variations in monsoon timings.¹⁵

The treatment regimen followed in the setting involved automatic shifting to Intensive Care Unit if presented with alleged snakebite irrespective of the presence or absence of symptoms. Then, the patient is assessed for the signs and symptoms of envenomation to differentiate between local and systemic envenomation. In case the snake species was brought along with, the species was identified on the basis of various morphologic features. Blood sample was obtained immediately and assessed for the bleeding and clotting time to assess for the haematologic abnormalities. Since viper can cause both neurotoxicity and haemotoxicity, the BT and CT were done even when the neurological symptoms were present. In case of derangement of the clotting functions, anti-snake venom was administered with initial dose depending on the severity of the presenting symptoms and further doses on the basis of titration of venom. A relatively greater quantity of antivenom was required in Russel's viper bite as evident from the mean quantity of ASV vials used. No prophylactic drug regimen has proved effective in reducing the incidence or severity of early antivenom reactions; these drugs should not be used except in high-risk patients. But in the institution under study, the prophylactic administration of inj. Avil and inj. Hydrocortisone followed by 1 ampoule ASV titrated in 100 ml NS has been given as test dose with positive outcomes and helped in detecting ASV reaction in 2 instances with test dose. All patients were administered with tetanus toxoid booster doses and antibiotic prophylaxis (cephalosporins) for

preventing infections during the period of stay. The patient was shifted from the critical care unit to ward only after the lab values were normal and there was no sign of complications.

Even though cobra bites produced only 5 casualties, the mean length of hospital stay was more than double the duration of Russel's viper casualties. HNV was responsible for second most frequent identified bites, and the lack of specific antivenom did not hinder the proper therapeutic management as reflected in the mean length of hospital stay, which was lower than other identified snakebites in the current study. The result contradicted observations of studies conducted in Sri Lanka where the HNV bites resulted in more intense toxicities.^{16–18}

Warmth and swelling at the location of bite was the most prominent clinical feature among victims, with a prevalence of 83.5% in the study sample. The value was higher than the 65.62% prevalence of swelling and oedema observed by Gupta et al. in a similar, but retrospective study.¹⁹ The average number of vials used in the current study of 15.62 ± 8.23 was similar to the average of 16 vials observed by Gupta et al. in his study setting. Although various studies in India cite predominance of different species involved in snakebite incidents, the most prevalent snake identified in the current setting was Russel's viper. HNV was the second most frequent causative species, however, with less appalling toxicity. Along with the comparatively lesser duration of hospital stay with HNV poisoning also indicated efficacy in therapy despite the absence of a specific monovalent antivenom. There has, however, been isolated instances of ASV usage in HNV bites, without any clinically observable efficacies, and such practices need to be curbed through prospective educational interventions coupled with institutional snakebite guidelines.

5. Conclusion

The study identified that, among the snakebite cases admitted to the institution, the causative species was unidentified in 52.7% instances. Russel's viper was appraised to have been involved in 23.1% of the total incidents, thereby constituting the most prevalent species among identified cases in the study setting. HNV, spectacled cobra and common krait occupied second, third and fourth places respectively in terms of institutional prevalence. Male gender, working class population, outdoor occupation without adequate protective footwear, monsoon season and rural residency were identified as risk factors for contracting snakebites.

The results obtained in the current institutional setting can be extrapolated to the whole of Malappuram district of Kerala, as majority of the snakebite cases in the district are brought into the institution for therapeutic management. However, the results may not be applicable to other parts of the state of Kerala due to the regional variations in the snake distribution. Therefore, institutional studies done at referral centres for snakebite casualties can be effective in identifying the regional prevalence and risk factors to plan for counter-active awareness campaigns.

Conflicts of interest

The authors have none to declare.

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